REMARKS

The Office Action dated November 19, 2009 has been received and carefully noted. The above amendments and following remarks are being submitted as a full and complete response thereto.

Claims 1-4, 6-7, 10-18 and 21-29 are pending. By this Amendment, Claim 23 has been cancelled without prejudice or disclaimer and the subject matter therein incorporated into Claim 22 by amendment. Support for the amendments to the claims may be found at least in the third paragraph of page 9 and the first full paragraph of page 14 of the application as originally filed. Applicants respectfully submit that no new subject matter is presented herein.

Claim Rejections -- 35 U.S.C. § 103

Claims 1-2, 7, 10 and 28 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,850,288 to Hoffert et al. ('288) in view of U.S. Patent No. 5,326,254 to Munk ('254). Claims 3-4, 6, 12-13 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of '254 as applied to claims 1-2, and further in view of U.S. Patent No. 6,848,375 to Kasin ('375). Claim 11 is rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of '254 as applied to claims 1-2, and further in view of U.S. Patent No. 4,022,591 to Staudinger ('591). Claims 14, 16, 18, 21-23 and 28 are rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of '254, and further in view of U.S. Patent No. 6,883,443 to Rettig et al. ('443). Claim 15 is rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of U.S. Patent No. 6,145,452 to Heger et al. ('452).

Claims 17 and 27 are rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of '254 as applied to claim 16, and further in view of '375. Claims 24-26 are rejected under 35 U.S.C. § 103(a) as being unpatentable over '288 in view of '591. Applicants respectfully traverse the rejections.

As stated in the third paragraph of page 9 of the application as originally filed, "[a]s a whole, the method of the present invention can ensure, over a wide range of types of materials in the physical form of solids, granular solids, liquids and sludges, the production, at the mouth of the reactor, of combustion fumes with a very low TOC (of the order of parts per million - ppm) and with a very low volatile ash content. This substantially simplifies the techniques for the post-treatment of the combustion fumes and renders the disposal of the liquid/solid phases used in the post-treatment much less of concern to the environment."

In describing the state of the prior art in the Specification, the Applicants note that, for example, U.S. Patent 5,337,683 describes a treatment of waste materials and refuse in a pressurized reactor into which air enriched with oxygen, possibly up to 100%, is injected. The disadvantages of the '683 solution reside in the fact that toxic furans and polyaromatics, such as dioxins, are formed in the obtained combustion gases. The presence of these compounds does not allow production of a combustion gas with low toxic organic substances (i.e., TOC), which is one of the key features that the present invention has solved. Similarly, as pointed out in the Specification, the prior art disclosed in U.S. Patents 5,309,850 and 6,029,588, which describe the combustion of combustible materials, produce toxic organic by-products (e.g., dioxins and furans) in the combustion fumes. Furthermore, the combustion fumes contain dust (volatile

ashes) comprising heavy metals, which are toxic and require post-treatment of the fumes.

With the present invention, the Applicants have surprisingly and unexpectedly found that by using the method of independent claim 1 and/or the apparatus of independent claim 14 of the present application, the problems of the prior art may be overcome. In particular, the present invention enables production, at the mouth of the reactor, of combustion fumes with a very low TOC (of the order of parts per million - ppm) and with a very low volatile ash content. As such, the present invention represents a solution to a very long felt need that, until the present application, was not a problem that was articulated in the prior art wherein a person of ordinary skill in the art could have combined elements of the prior art to arrive at the solution of the problems indicated above.

The Office Action asserts that Hoffert discloses all the features of Claim 1 except for recycled gases being supplied to the combustion reactor or water being injected into the recycled gases to raise the concentration of water in the recycled gases. The Office Action looks to Munk to cure the stated deficiencies of Hoffert, asserting that Munk teaches recycling flue gases to a combustion chamber and water being injected into the recycled gases to raise the concentration of water in the recycled gases and, therefore, it would have been obvious for one of ordinary skill in the art at the time of invention to combine the combustion apparatus of Hoffert with the flue gas humidification/ recirculation of Munk because such a combination would have produced the added benefit of reduced NOx emissions and a more efficient combustion process.

Hoffert relates to burners for the burning of solid fuels (e.g., see col. 2 lines 3-15).

Hoffert states that the burning of solid fuels, unlike burning vaporous and volatile liquid fuels, requires increased reaction time constants which are orders of magnitude longer to complete combustion. For reducing the longer combustion times, it had been proposed to reduce the fed solids size. However, according to Hoffert, this solution still does not permit the burning of solid fuel materials at combustion rates which approximate those of non-solid fuels (see Background section of Hoffert).

Hoffert has developed a burner for burning solid fuels wherein fuel particles having higher mass are retained for very long periods of time relative to the combustible volatiles (col. 2, lines 18-23). In the combustion process of Hoffert, high volumetric heat release rates approaching those for liquid and gaseous fuels are provided (col. 3, lines 25-27). The combustion method of Hoffert is a pressurized cyclonic combustion method. Clean pressurized hot effluent gases are produced that can be expanded in a gas turbine to produce power (e.g., see the Abstract). The burner apparatus is a cylindrical pressurized burner which utilizes helical flow patterns to provide prolonged combustion of the fuel solids and uses an intermediate choke zone and an air quench step to improve combustion and control temperature of the produced effluent gases (col. 1, lines 17-26). Hoffert has found that the addition of acceleration air along the helical path promotes rapid oxidation of the solid fuel (col. 3, lines 2-4).

The burner, or primary combustion chamber, operates at a pressure from 3 atm to 20 atm (col. 3, lines 38-43). The burner combustion chamber terminates with a choke opening 20a (Fig. 1) (col. 4, lines 53-54). The position of the choke opening can also be changed to facilitate the passage of ash from the primary combustion chamber

(col. 6, lines 56-58). Downstream from the choke, there is the secondary combustion chamber (col. 4, lines 62-63)

The hot pressurized gas produced in the primary combustion chamber is usually at a temperature of about 2100°-2800°F and is cooled in the secondary combustion chamber by mixing with a quench gas such as compressed air or steam (col. 8, lines 1-2) to reduce the gas temperature to about 1400°-2000°F (col. 4, lines 20-28). Fig. 1 shows that quench gas is added through the opening 30 in the secondary combustion chamber. Any remaining solids in the effluent gas can be separated from the gas in a cyclone separator (col. 4, lines 32-34)

Fig. 6 represents the apparatus used for the combustion process of the example of Hoffert. The solid fuel material, which in this case is wood particulate, is delivered into the pressurized conveying conduit 118 wherein pressurized transport air pneumatically conveys the particulate solid material tangentially to the pressurized burner 10 (see the paragraph bridging cols. 9-10). Combustion air is introduced tangentially into the primary combustion chamber 15 through multiple spaced-apart openings or tuyeres 18a, 18b, 18c, etc. (col. 10, lines 44-49).

The Applicants note that the technical problem of Hoffert is to provide very high volumetric heat release rates approaching those for liquid and gaseous fluid (col. 3, lines 26-27). As such, the technical problem addressed by Hoffert has nothing to do with the technical problem solved by the present invention, that is, the production at the mouth of the reactor of combustion fumes with a very low content of TOC (of the order of ppm) and volatile ash content. Hoffert does not address TOC. As to fly ash, Hoffert discloses that the fly ashes are removed downhill from the combustor by a cyclone.

Therefore, the combustion process of Hoffert produces fly ash, which is specifically avoided by the solution provided by the claimed invention. The combustion process of Hoffert does not reduce to a negligible value the fraction of dust that is entrained out of the reactor with the burnt gases at the mouth of the reactor. Rather, Hoffert discloses that it is essential to use the cyclone apparatus to remove the dust, which is unnecessary with the present invention. Furthermore, Fig. 6 of Hoffert shows that the solid fuel is fed into the burner 10 admixed with air. As such, the fuel is mixed with a comburent comprising oxygen. Accordingly, the Applicants respectfully submit that one of ordinary skill in the art would never be motivated to consider Hoffert in order to obtain a very low TOC and volatile ash content of combustion fumes at the mouth of the reactor.

Munk discloses an apparatus to reduce noxious emissions from a burner. Munk states that it is known to recirculate combustion gases for reducing noxious emissions (col. 1, lines 29-36). However, the fraction of the recirculated gas that can be fed back to the burner input is approximately 25%, since at higher percentages problems of flame stability arise (col. 1, lines 49-52). Munk aims to obtain a further reduction of noxious emissions without undue sacrifice of flame stability and/or burner efficiency (col. 1, lines 58-60).

The solution disclosed by Munk is a fogging device, i.e. an apparatus for producing water/steam, which humidifies the recirculated flue gas (see the Abstract). The flue gas recirculation system 230 includes a damper 132, a blower 134, a recirculation supply damper 138, and a duct 135, which couples to a recirculation input of a burner 115. The burner also has an air input 116. Munk further states that the

recirculation and air inputs can either be separately fed to the burner or can be mixed at any desired point (see col. 2, lines 60-67, and Fig. 2).

The Applicants respectfully submit that Munk also provides no motivation for one of ordinary skill in the art to conclude that combining aspects of the process described in Munk with the process described in Hoffert would bring about the solution of the technical problem of the present invention. In fact, the Office Action states in the last sentence of paragraph 7, bridging pages 4 and 5, that one of ordinary skill in the art would have modified Hoffert in view of Munk because the combination would have the added benefits of reduced NOx emissions and a more efficient combustion process. The Applicants respectfully submit that reduced NOx emissions does not arrive at the solution of the technical problem of the present invention, namely, the production, at the mouth of the reactor, of combustion fumes with a very low TOC (of the order of parts per million - ppm) and with a very low volatile ash content. Moreover, the Office Action states that Hoffert combined with Munk teaches the present invention except for the concentration of water in the recycled gases higher than 30% by volume, as set forth in present Claim 1, and that it would have been obvious to have the concentration of water in the recycled gases higher than 30%, since it has been held that discovering an optimum value of a result effective variable involves only routine skill. For the same reasons discussed above, the Applicants respectfully submit that the concentration of water in the recycled gases being higher than 30% by volume is far from being an optimization, as the prior art does not teach or suggest to one of ordinary skill in the art the solution to the technical problem resolved by independent Claims 1 and 14.

The Office Action asserts that Kasin teaches that the recirculation gases from combustion are supplied at minimized temperature (col. 4, lines 38-40) so as to minimize the overall volume of gas in the reactor for gas residence time in the reactor and to ensure the removal of the reaction heat from the reactor, wherein the mixing of the oxygen with the recycled combustion gases takes place with a concentration of more than 10% by volume and preferably more than 60% by volume (Col. 8, lines 48-54). Kasin relates to a method and device for converting energy by combustion of solid fuel, especially incineration of bio-organic fuels and municipal solid waste, to produce heat energy and which operates with very low levels of NO_x, CO and fly ash (col. 1, lines 4-8). The main features of the energy converter of Kasin include controlling the oxygen flow in the combustion chamber by regulating the flow of fresh air which is fed into the chamber (col. 3, lines 50-51), controlling the temperature in the combustion chamber by admixing a regulated amount of the recycled flue gas with the flow of fresh air (col. 3, lines 55-57), and filtering the recycled flue gas and fresh combustion gases in unburned solid waste in a first combustion chamber by sending the unburned solid waste and the gases in a counter-flow direction before entering the gases into the second combustion chamber (col. 3, lines 59-63). In this way, a large portion of the fly ash and other solid particles entrained in the gas leaving the combustion chamber are removed (col. 4, lines 62-63).

The plant of Kasin, as shown in Fig. 2, comprises a primary combustion chamber 1, a secondary combustion chamber 30 with a cyclone (not shown), a boiler 40, a gas filter 43, a pipe system for recycling and transportation of flue gas, and a pipe system for supplying fresh air (col. 5, lines 24-29). The cyclone, which is attached at the outlet of the second combustion chamber, helps reduce the content of fly ash and other entrained solid

particles in the gas flow (col. 11, lines 45-46). The gas filter 43 brings an additional reduction of fly ash and other pollutants of the flue gas before they are discharged as exhaust gas (col. 12, lines 25-28).

In example 1, Kasin discloses that the internal pressure in the primary combustion chamber is kept approximately 80 Pa below the surrounding atmospheric pressure and in the secondary combustion chamber approximately 30 Pa below the pressure in the primary combustion chamber (see col. 12, lines 64-67 and col. 13 lines 4-6). The Applicants respectfully submit that Kasin also does not teach or suggest reduction of fly ash and TOC content in the combustion fumes at the mouth of the reactor. Rather, Kasin discloses positioning a cyclone after the secondary combustion chamber, followed by a gas filter inserted after the boiler. The presence of a cyclone and a gas filter in the combustion apparatus of Kasin indicates to one of ordinary skill in the art that combustion fumes having a very low volatile ash content are not produced at the mouth of the reactor.

Furthermore, Kasin discloses that the primary combustion chamber is operated at a pressure below the surrounding atmospheric pressure and that the secondary combustion chamber is operated at a pressure lower than the pressure of the primary combustion chamber. Hoffert, however, teaches operation of the burner 10 above atmospheric pressure (col. 6, lines 26-37). Accordingly, in view of these antithetic teachings for the reactor operating pressures, one of ordinary skill in the art would not be motivated to combine Hoffert in view of Munk and further in view of Kasin, as doing so would render the primary reference, Hoffert, unfit for its intended purpose, not to mention would fail to produce the invention recited by Claims 1 and 14.

Staudinger is cited for disclosing a slag quencher. The Applicants respectfully submit that Staudinger does not cure the deficiencies with respect to Hoffert, Munk, and Kasin, namely, the production of combustion fumes having a very low TOC and volatile ash content at the mouth of the reactor.

Staudinger discloses an apparatus for the continuous gasification of coal by partial combustion with a reactant gas. The Background of Staudinger states that a number of processes and apparatuses have been developed for coal gasification and that many of these known processes and apparatuses have been devised and employed to produce a product gas comprised primarily of carbon monoxide and hydrogen. Such product gases are extremely useful as a fuel, whether further treated or not, and are important base materials for chemical syntheses such as the preparation of ammonia and hydrocarbons (col. 1, lines 11-26).

In the coal gasification processes and apparatuses, there is a problem of removing the non-carbonaceous, mineral residue produced during gasification from the reactor apparatus. Without the employment of special precautions, the residue, or ash content, may accumulate in undesirable places in the gasifier apparatus, thereby adversely affecting the gasification (col. 1, lines 28-35). The apparatus of Staudinger, as shown in Fig. 1, includes a vertical gasification reactor wherein coal is supplied through an inner tube 14a and oxygen both through the outer tube 14b and through inlets 26. Ash particles are removed to and from the reactor via a constricted passageway in the reactor bottom. The quench water is supplied to inlet 16 to cool ash particles. The cooled slags are removed through an outlet 18 (see the Abstract).

Staudinger is directed to a gasification process. Accordingly, the Applicants respectfully submit that Staudinger does not teach or suggest to one of ordinary skill in the art, and actually teaches away from, the process of the present invention as disclosed in Claims 1 and 14, wherein the formation of high concentrations of CO_2 and H_2O are desired to produce combustion fumes at the mouth of the reactor having a very low TOC and volatile ash content.

Rettig is cited for teaching the use of recirculated flue gas as a quench gas. Rettig discloses a method for reducing the slagging and fouling of the surfaces of the waterwalls, firebox, superheater, and reheater of the furnace of a coal fired steam boiler, wherein the firebox exit temperature of flue gas is lowered to below the specific ash melting temperature (col. 2, lines 8-24). Recirculated flue gas from downstream of the electrostatic precipitator, or atomized water or a sorbent water slurry, are injected into ports located in the upper section of the firebox (col. 2, lines 13-18). As shown in Fig. 2, port 295, located in the upper section of the firebox 210, is for the flue gas duct 290 (col. 6, lines 1-4). The sorbent water slurry and atomized water that can be used in place of the flue gas, may be injected at the same port (see col. 6, lines 44-48, col. 2, lines 45-50). An air feed is positioned in the firebox near the coal feed, which is separated from the previous feeds used in Rettig for reducing the exit temperature of flue gas. The flue gas from the firebox, after passing through the air preheater (260), goes through an electrostatic precipitator ESP (270) wherein the flue gas is cleaned from fly ashes (col. 5, lines 57-61).

The Applicants respectfully submit that Rettig also does not teach or suggest to one of ordinary skill art the production at the mouth of the firebox of combustion fumes

having a very low TOC and volatile ash content. As is the case with Hoffert, for example, Rettig teaches removal of pollutants, including fly ash, through the use of additional equipment, such as an electrostatic precipitator, downhill of the combustor. Rettig, in addition, is silent on how to reduce TOC.

Heger is cited for disclosing walls of a reactor comprising a ceramic lining material which participates in the isothermy or quasi-isothermy of the reactor. Heger discloses an arrangement for insulating a wall of a metallic combustion chamber. A layer of insulating material is applied to the metallic wall and a plurality of ceramic wall panels are applied over the ceramic insulation material. The wall panels are retained by fastening elements that pass through an opening in the wall panels. The Applicants respectfully submit that Heger also does not teach or suggest to one of ordinary skill in the art the features of Claims 1 and 14 that result in the production at the mouth of the reactor of combustion fumes having a very low TOC and volatile ash content.

For at least the reason(s) provided above, the Applicants respectfully submit that Hoffert, Munk, Kasin, Staudinger, Rettig, and Heger, alone or by any combination, do not disclose, teach or suggest, and teach away from certain of, the features of the present invention, as recited by Claims 1 and 14. As such, the Applicants respectfully submit that one of ordinary skill in the art would not find it obvious to modify Hoffert according to the teachings of Munk, Kasin, Staudinger, Rettig, and Heger, alone or in combination, because to do so would not arrive at the invention recited by Claims 1 and 14, respectively, and, in some cases, would render Hoffert unfit for its intended purpose. Accordingly, the Applicants submit that Claims 1 and 14 should be deemed allowable over Hoffert, Munk, Kasin, Staudinger, Rettig, and Heger.

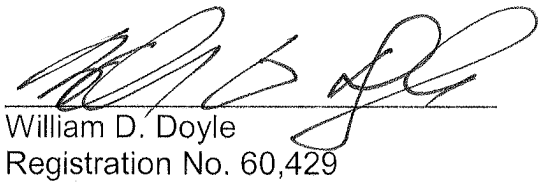
Conclusion

In view of the foregoing, the Applicants respectfully request reconsideration of the application, withdrawal of the outstanding rejections, allowance of Claims 1-4, 6-7, 10-18, and 21-22 and 24-29, and the prompt issuance of a Notice of Allowability.

Should the Examiner believe anything further is desirable in order to place this application in better condition for allowance, the Examiner is requested to contact the undersigned at the telephone number listed below.

In the event this paper is not considered to be timely filed, the Applicant respectfully petitions for an appropriate extension of time. Any fees for such an extension, together with any additional fees that may be due with respect to this paper, may be charged to counsel's Deposit Account No. 01-2300, **referencing attorney docket number 108907-00043**.

Respectfully submitted,



William D. Doyle
Registration No. 60,429

Customer No. 004372
ARENT FOX LLP
1050 Connecticut Avenue, N.W., Suite 400
Washington, D.C. 20036-5339
Tel: (202) 857-6000
Fax: (202) 638-4810

WDD:elp